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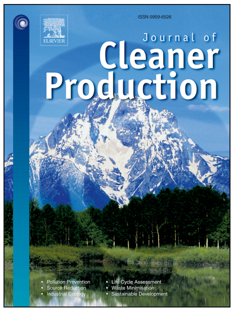

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Water research in support of the Sustainable Development Goal 6: a case study in Belgium

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Abstract

Reaching the Sustainable Development Goal (SDG) 6 on water and sanitation is fundamentally important and conditional to the achievement of all the other SDGs. Nonetheless, achieving this goal by 2030 is challenging, especially in the Global South. Science lies at the root of sustainable development and is a key of new solutions for addressing SDG 6. However, SDG 6-related scientific outputs are often unknown, forming disconnections between academic world and practitioners implementing solutions. This study proposed a bibliometric and text mining method to qualitatively and quantitatively characterize the contribution of water research to the achievement of SDG 6. The method was applied for water research produced by Belgian-affiliated authors with a focus on the Global South collaboration. Despite accounting for less than one percent of the total global publications, Belgian water research has had a relatively high publication rate compared to its neighboring countries. We observed longstanding collaborations between Belgian and scientists from worldwide countries, and an increasing collaboration rate with countries from the Global South. The biggest share of publications focused on topics related to the targets 6.3, 6.4, 6.5, and 6.6, with the main hotspots for Belgian water research being water treatment, water stress, water pollution, climate change, and water modelling. The findings of the bibliometric search have been integrated into an online, user-friendly dashboard to facilitate the identification of research body and experts for practitioners and policy makers. The presented methodology is sufficiently generic and can be used to optimize other science programs in relation to the 2030 Agenda in other countries and regions. In this case study, the findings support shaping the Belgian cooperation and development policy in the water sector, and creating appropriate synergies between Belgian water researchers and their counterparts in the Global South.

Keywords: Water research; Belgium; Sustainable Development Goals; SDG 6; Bibliometrics; Global South; North-South collaboration

1. Introduction

Clean water and proper sanitation are essential for survival as being explicitly recognized by the United Nations in 2010 as a human right (UN General Assembly, 2010). Five years later, this acknowledgment was again underlined in the 2030 Agenda for Sustainable Development with the Sustainable Development Goal 6 (SDG 6) that aims to ensure availability and sustainable management of water and sanitation for all by 2030 (UN General Assembly, 2015). Eight global targets in SDG 6 cover the whole water cycle including provision of drinking water (target 6.1) and sanitation and hygiene services (6.2), treatment and reuse of wastewater and ambient water quality (6.3), water-use efficiency and scarcity (6.4), integrated water resources management (IWRM) including through transboundary cooperation (6.5), protecting and restoring water-related ecosystems (6.6), international cooperation and capacity building (6.a) and participation in water and sanitation management (6.b) (UN Water, 2016). As stated in the report of UN Water (2018), water availability and quality are essential elements for the progress in human society, environmental well-being, and economic welfare.

In this regard, a failure to deliver the SDG 6 can jeopardize the whole 2030 Agenda. However, several reports have concluded that the world is not on track to achieve this goal (Independent Group of Scientists appointed by the Secretary-General, 2019; Nilsson et al., 2015). For example, in 2015, 1.8 billion people still had to use fecally contaminated drinking water and 80% of wastewater from human activities was still being discharged directly into water-related ecosystems (United Nations, 2015). Consequently, diarrheal diseases are spreading and causing the death of an estimated 801,000 children younger than 5 years in developing countries every year (Liu et al., 2012).

Science lies at the root of sustainable development. Novel scientific insights combined with cross-cutting technologies and innovations are instrumental to overcome pressing global and local challenges and achieve the SDGs and beyond (Independent Group of Scientists appointed by the Secretary-General, 2019). Science, technology, and innovation (STI) were also recognized by the European Commission as a prerequisite to implement the new Agenda (Nilsson et al., 2015). In the water sector, digital technologies, artificial intelligence (AI), automation, bio-, and nanotechnologies have already been showing their far-reaching impacts and opportunities universally (Messner et al., 2019). In contrast to the business-as-usual practices, the next generation of the water system management securing sustainable water future needs to embrace the solutions derived from science and technology. However, capitalizing STI for the design of water systems strategies and policies remain challenging, which can jeopardize the achievement of the SDG 6.

From this perspective, this study aims to develop a systematic analysis to quantitatively and qualitatively assess the past and current contribution of water research in support of the achievement of SDG 6 and each of its targets. We applied the analysis on Belgian water research and its collaboration with Global South countries due to the following reasons. Firstly, although water is not a limited resource and almost entire population in Belgium is receiving high-quality drinking water and sanitation, intensive habitat, industrial, and agricultural activities are leading to a high amount of freshwater withdrawal in Belgium (Amore, 2012; PMO Belgium, 2017) . Hence, Belgium becomes one of the countries facing high water stress (FAO, 2018). Besides, intensive agriculture leading to diffuse pollution, hydrological regulation and river morphological modifications, pressures the surface water quality in Belgium (Gabriels et al., 2010). Consequently, much higher concentration of both nitrate and phosphate has been found in many Belgian rivers compared to the average values of the EU region (EEA, 2015). Hence, the water issues in Belgium and the achievement of the SDG 6 targets in Belgium remain a challenge. Also, Belgium is characterized by an open economy, strongly oriented towards international cooperation in different sectors. Yet, the role of Belgium cooperation for development in the water sector is poorly recognized (Tröltzsch et al., 2016). Equally important, global partnership and North-South international cooperation are emphasized to strengthen knowledge sharing and transfer of STI in SDG 17 of the 2030 Agenda (UN General Assembly, 2015). It was concluded that highly uneven global distribution of scientific capacity and knowledge access threatens to disrupt the 2030 Agenda. Hence, a major coordinated effort from all nations is urgently required to free relevant scientific knowledge, especially to Global South countries, and to build a common knowledge platform in the future (Independent Group of Scientists appointed by the Secretary-General, 2019). The common knowledge platform has been facilitated by the development of the

Internet and the movement to provide open access (OA) to all research literature (Piwowar et al., 2018).

To this end, a bibliometric analysis and text mining method were applied to investigate systematically publications targeting the water sector with a wide spectrum of complementary expertise, from integrated water management, sanitation and hygiene, policy support for sustainable transitions natural resources governance and legal aspects, private sector development and valorization of research to data analytics and decision support systems for water and environmental management. Particularly, the proposed method can be used to design scientific agenda in support of the development and policy of the water sector in Belgium as well as its collaboration with the Global South. The methodology that is presented is sufficiently generic and can be applied to evaluate the role of STI in the achievement of other SDGs in the Agenda 2030. However, it is important to keep in mind that while the natural and technical sciences can be well-covered in bibliographic databases, literature of the social sciences is partially represented, likely limiting the applicability of the method for the SDGs in the human social sphere (Bornmann and Leydesdorff, 2014).

2. Materials and methods

Bibliometrics was first presented by Pritchard (1969) as a method to gain a systematic, transparent, and reproducible review on the existing knowledge base within a given area (Aria and Cuccurullo, 2017; Ho and Goethals, 2019; Rousseau et al., 2018; Yao et al., 2018). Bibliometrics applies advanced quantitative analyses and statistical methods to assess scientific output in a given field. Bibliometrics is therefore an appropriate methodology to assess Belgium water research. Text mining is a complementary technique facilitated by new internet browsing technology. Bibliometrics and text mining were applied to identify and evaluate research hotspots and tendencies of Belgian water research in general and particularly in the context of Belgium-Global South collaboration. Particularly, we analyzed current and historic peer-reviewed literature body addressing topics related to SDG 6. We applied multiple search queries and text mining based on authors' keywords to portray the water research conducted by Belgian-affiliated authors, and compared it with the research conducted by neighbor countries and globally. To shed light on how Belgian scientists connect with authors globally, we mapped the number of water publications published by Belgian authors and authors around the world. We also had a specific focus on the publications sharing authorship with researchers from the Global South countries.

2.1. Data collection

Bibliographic data were collected on the Scopus website (www.scopus.com) on December 14, 2019. Scopus database contains the largest international abstract and citation collection of peer-reviewed scientific literature. Scopus currently indexes 24,600 titles (journals, magazines, reports) from more than 5,000 international publishers (Scopus Elsevier, 2016). To select publications related to SDG 6, we first built a list of relevant filtering terms. We started with an initial list of 1,057 terms proposed for the bibliometric analysis of water research by the United Nations University (Mehmood (2019). To address some inconsistencies and adapt the list to a list of terms solely related to SDG 6 and its targets, we conducted a three steps adaptation procedure. In the first step, we eliminated terms because of their irrelevance based on five criteria (off-topic, too general, too specific, redundant, duplicated term). Details regarding these criteria can be found in Supplementary Material A. In a second step, the remaining terms were categorized into the eight targets of SDG 6. When necessary, additional terms were added to fully capture the theme addressed by the targets. The selection of new terms was based on the definitions of the targets and their indicators. Importantly, a term could be categorized into multiple targets. For example, 'wastewater' was considered for both targets 6.3 and 6.4. Also noteworthy is that given the broad implications of integrated water resources management (IWRM) tackled by target 6.5, a wide range of terms were chosen, such as terms linked with hydrology, water resources, and water modeling. The first and second steps were implemented by three water professionals separately and then compiled into a single list. We discussed the terms for which there was a disagreement among the three scientists and made decisions on a case-by-case basis. In the final step, the chosen terms for SDG 6 and its targets were assessed and revised by two senior researchers with extended experience in the water sector. The final lists of terms for SDG 6 and its targets can be found in Supplementary Material B.

Subsequently, we applied these terms to a search query to download the citations and bibliographies directly in Scopus website as well as in open-source statistical software R (R Core Team, 2014) using **rscopus** package (Muschelli III, 2018). A common template of the search query applied in Scopus was as follows: TITLE (*) OR AUTHKEY (*) AND AFFILCOUNTRY(**). The TITLE (*) OR AUTHKEY (*) fields, referring to title and a list of author keywords of a publication, were filled with the final lists of terms for SDG 6 and its target while the AFFILCOUNTRY(**) field was filled with the name of the country, such as Belgium. Note that by simply changing the AFFILCOUNTRY(**) field with the name of a country or region of interest in the search query, one can explore the contribution of the water research of that country or region to the achievement of SDG 6. This template can show a wide range of publications from multidisciplinary fields in which water plays a crucial role in their development. All publications of water research were collected from 1926 to 2019 as 1926 was the farthest year of the Scopus record for this particular search. These publications were assessed for the following characteristics: document type and language, publication output, research category, publishing journal, affiliation country, affiliation institutions, and authors' keywords. To this end, **bibliometrix** package in R (Aria and Cuccurullo, 2017) and **VOSviewer** software (van Eck and Waltman, 2010) were applied for text mining and data analysis.

2.2. Research keywords and hotspots

We selected author's keywords to reveal the hotspots and the emerging trends in scientific research. Particularly, we analyzed authors' keywords looking at different periods, i.e. 1990-1999, 2000-2009, and 2010-2019, to investigate how the main research lines of Belgian water research evolved through time. These periods are chosen because one needs to take into account historical as well as current contribution of science in sustainable development since scientific knowledge has always been at the root of sustainable development. However, it should be kept in mind the incomplete collection of early publications (pre-1990) in Scopus databases which were also one of the reasons why numerous bibliometric analyses only considered publications after 1990 (Ho, Long and Goethals, Peter, 2020; Jiang et al., 2016; McCallen et al., 2019; Qian et al., 2015). We represented the authors' keywords in a distance-based map using the VOSviewer application (van Eck and Waltman, 2010). In such a map, the distance between two keywords reflects the strength of co-occurrence, and the clusters group keywords that are frequently combined in a set of author keywords (Van Eck and Waltman, 2007). To limit the outputs, we imposed the minimum number of appearance of a keyword to the top 100 most frequent keywords.

2.3. Dashboard

Equally important, to facilitate the data accessibility, analysis and visualization of the readers, we developed an interactive application using R **Shiny** package (Chang et al., 2015). This application allows customization of the application's user-interface to provide an elegant environment for displaying user-input controls and simulation output (Wojciechowski et al., 2015). The output can be simultaneously updated with changing input. Thanks to this ability, the users can access, analyze, and visualize the collected publications in a quick, flexible, and informative way. Our Shiny application is available online at https://water-research.shinyapps.io/Belgian_water_research/.

3. Results and discussion

3.1. Water research in Belgium

3.1.1. Document type, yearly output, language of publications and citations

The total number of water publications in Belgium amounted to 5,703, the first being published in 1926, and from which more than 50% were published during the last decade (2010 – 2019). Article was the most frequently published document type (82%), followed by conference paper (10%), review (4%), and book chapter (2%). English was the predominant language (95%), followed by French (3%) and Dutch (1%).

Overall, 14% of Belgian water research was published with an open-access (OA). This number has accelerated dramatically, from 5% between 1926 and 2010 to 23% between 2010 and 2019, which put Belgium before the US (19%), France (19%) and China (13%), but behind the UK (25%) and the Netherlands (30%), and almost even with Germany and the average for the EU 28 (22% for both). High OA proportion in Belgian water research was induced by the support of numerous Belgian universities to OA for publications in which an immediate deposit and open access strategy at the University de Liege in 2007 initially paved a way for Belgian OA mandates (Septon and Van Hee, 2015). More than 15 Belgian institutions have adopted this assessment after that. Thanks to OA movement worldwide, scientists and researchers in the Global South have been increasingly getting access to scholarly and scientific publications and electronic resources, which has facilitated access to science and knowledge for achieving the millennium development goals (MDGs) (Chan, 2005).

Water treatment and pollution were predominant topics among the top ten most cited publications (Supplementary Material C). However, other research lines, such as modeling, seawater intrusion, greenhouse gas emissions from inland waters, and water functions in plants, also attracted many citations, which revealed diverse expertise in the Belgian scientific landscape. The top three most frequent publishers were *Water Research*, *Water Science and Technology*, and *Science of the Total Environment*. Twenty-five percent of the 20 most frequent publishers targeted the research focusing on agriculture, which was indicative of high concern of agricultural water that is needed to grow crops and sustain livestock. More details of the most frequent journals publishing Belgian water research over different periods can be found in Figures D1-D4 in Supplementary Material D.

Water research has witnessed a rapid increase in publications of Belgian water research for the last two decades, from around 20 publications per year during the 90s' to more than 120 in 2019. Although the research body by Belgian authors was smaller than neighboring countries (Figure 1), the Belgian contribution remained significant relative to other countries when reported to the number of inhabitants. In 2019, Belgian water research had a publication rate of 2.9 publications per 100,000 inhabitants, which was higher than France (1.9), and Germany (2.1), but lower than the United Kingdom (3.1) and the Netherlands (4.8). While EU countries has had the biggest share in water research publications over the last decade, China became the most productive country in 2019 (Figure 1). This result was likely a direct consequence of a heavy investment program in research and development (R&D) in China. China became the second-largest spender for R&D in 2017 after the United States with around 21% of the world's total expense, around 370.6 billion dollars (OECD (2017). More details of the publication performance can be found in Figure D5 in Supplementary Material D.

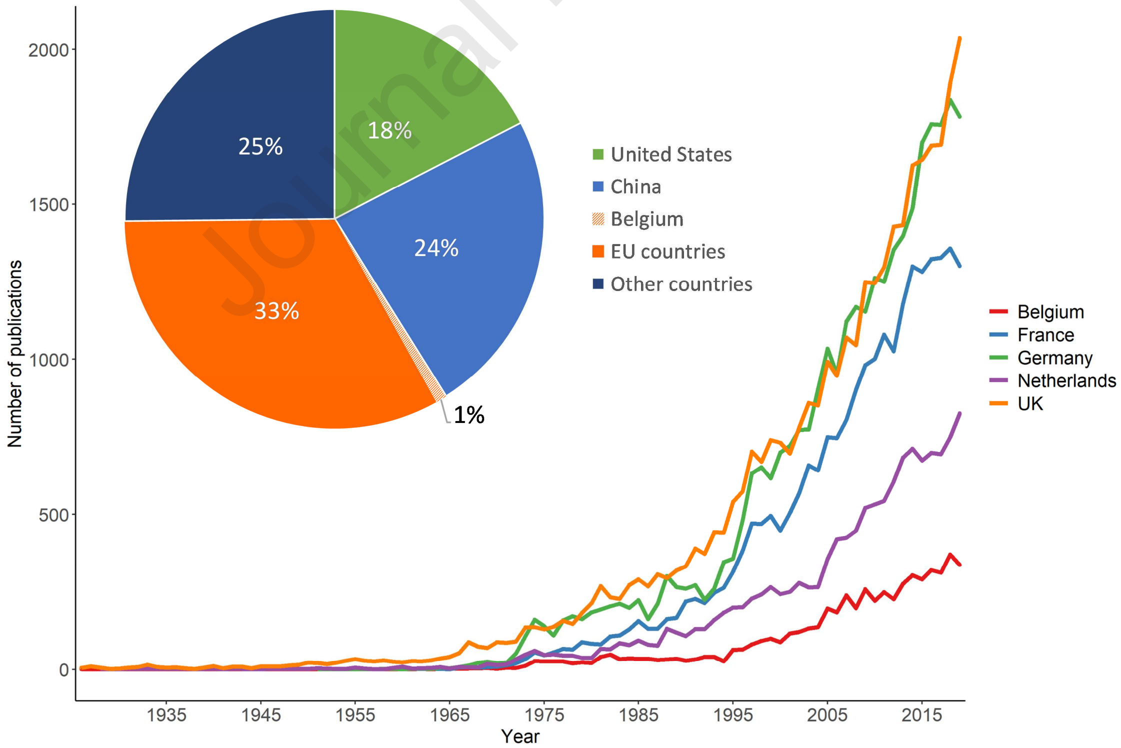

Figure 1. Number of publications of Belgian water research from 1926 to 2019 in comparison to neighboring countries. The pie chart shows the proportion of water publications by different world regions from 2010 to 2019.

3.1.2. Research collaborations

Belgian water scientists have co-authored with scientists from 108 countries (Figure 2), which revealed their vast international network. This network has rapidly intensified over the last 20 years (between 1999 and 2019), with only 46 countries in 1999 and 65 in 2009. The top five countries of collaboration until 2010 were United States, Netherlands, France, United Kingdom, and Germany. It appears that geography has been an important factor contributing to the long standing collaborations as except for the United States, the other countries are neighboring countries of Belgium. The collaboration of Belgian water researchers with their counterparts in the US has been induced by the fact that the US has been the most productive scientific publisher in the world. However, its gap with China is closing rapidly. In this regard, the collaboration with China has seen a notable increase, from 4 shared publications before 2000 to 21 between 2000 and 2009, and 144 from 2010 to 2019, making China the third-largest co-authoring country during the last decade. On the other hand, while the United States was ranked first in terms of shared publication numbers before 2000, it shifted down to the fifth position over the last decade (Supplementary Material D).

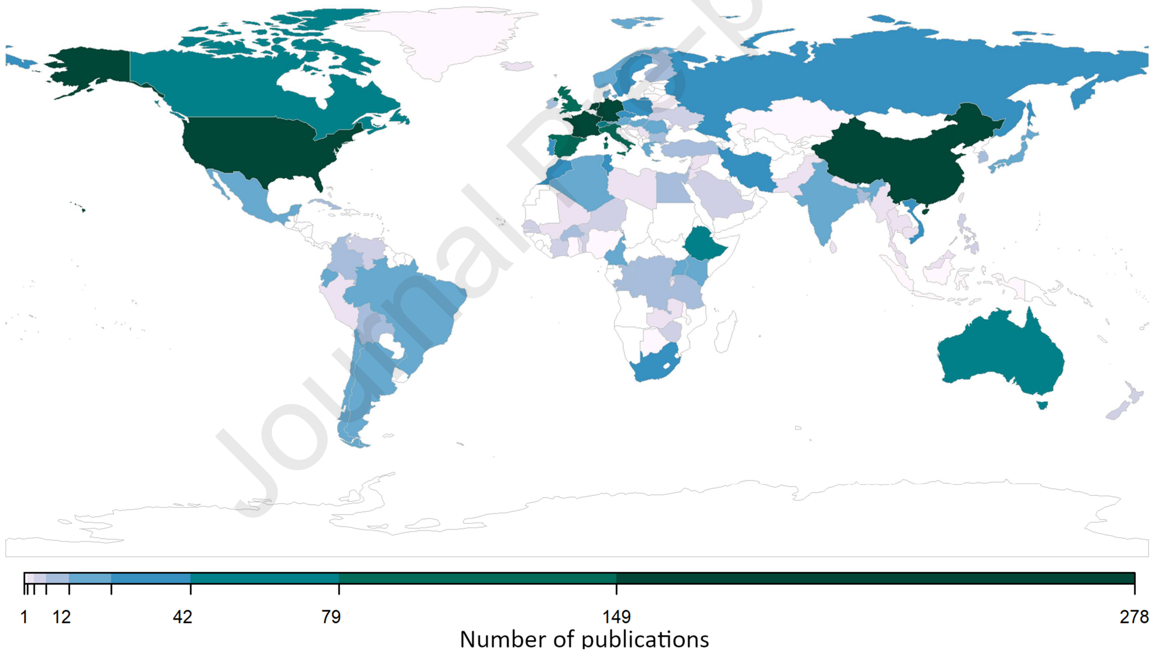

Figure 2. Map of the countries collaborating with Belgian institutions in water research from 1926 to 2019.

Importantly, among the 43 new research collaborations created over the last decade, 27 were countries from the Global South. Whereas first publications published with an international team was in 1957, the first paper co-authored with an institution from the Global South was in 1986. Ethiopia has a particularly rich shared publication record (56 shared publications within the last 10 years), which placed the country second after China. These fruitful collaborations were likely a result of historical support of more than 15 consecutive years from the VLIR-UOS, which has been enforcing partnerships between universities and university colleges in Flanders and the Global South (VLIR-UOS, 2013). In addition, other Global South countries in the top six were South Africa, Viet Nam, Tunisia, and Morocco. These countries have also been the strategic partners of university collaboration within the framework of VLIR-UOS and ARES-CCD, two regional organizations supporting university development cooperation. This trend indicated a significant increase in research collaboration between Belgium and countries in the Global South. Details of the top 20 countries and institutions can be found in Supplementary Material D (Figures D6-D17).

Regarding Belgian national institutions, Ghent University has been dominant in Belgian water research with around 1.000 publications, followed by KU Leuven (661 publications), University of Liège (310 publications), UC Louvain (291 publications), Universiteit Antwerpen (254 publications), Vrije Universiteit of Brussels (218 publications), and Université Libre de Bruxelles (179 publications). The other institutions had less than 100 publications. This ranking has remained relatively unchanged over the whole period of the record (Supplementary Material D, Figures D18-D21).

3.2. Research hotspots

3.2.1. Belgian water research

Figure 3 shows six clusters of Belgian water research, including (1) (waste/drinking)water treatment (679 occurrences); (2) water stress (601 occurrences); (3) water management (560 occurrences); (4) water quality (monitoring) (474 occurrences); (5) climate change (367 occurrences); and (6) water pollution (363 occurrences).

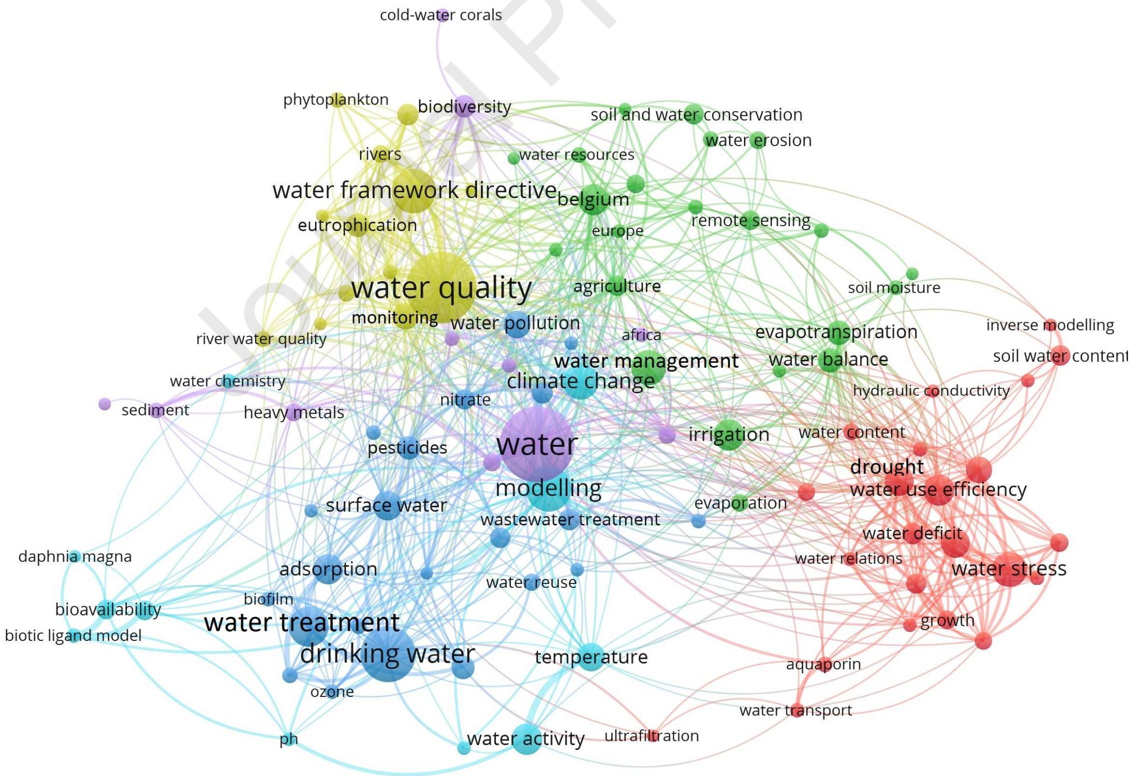

Figure 3. Most concerned keywords on Belgian water research from 1926 to 2019. The size of the text and circle are proportional to the number of publications. The keywords with the same color belong to one cluster representing their co-occurrence in publications. Some circles do not have text for clarity.

Water treatment. A research line that has received most attention focuses on (waste/drinking) water treatment with the most popular keywords on the list, i.e. drinking water (107 occurrences), water treatment (68 occurrences), and wastewater treatment (29 occurrences). In this cluster, water researchers have focused on advanced treatment technologies, such as carbon adsorption (67 occurrences), membranes design (64 occurrences, including nanofiltration, ultrafiltration, and nanoparticles), ozone treatment (18 occurrences), and biofilm treatment (17 occurrences). These technologies have been applied for treating waste and drinking water, and for tackling water pollution in surface water (44 occurrences), groundwater (29 occurrences), and sediment (17 occurrences). Recently, they also have been applied for emerging pollutants and xenobiotics, such as pesticides (34 occurrences) and pharmaceuticals (15 occurrences). Thanks to the increasing interest of scientific experts and the more constraining European environmental regulation, the degree of wastewater purification in Belgium have increased from 26% to 83% in the last 25 years (Vlaamse Milieumaatschappij, 2018).

Water stress. Since Belgium is one of the countries facing high water pressure, water stress (87 occurrences, including water deficit) has been the focus of Belgian water research. This concern was demonstrated by the high number of the most concerned keywords related to these topics such as temperature (153 occurrences), drought (95 occurrences), water stress (57 occurrences), hydrology (53 occurrences), and precipitation (52 occurrences). Another topic handled particularly by Belgian water scientists was related to the negative influences of climate change on crops. This was one of the relevant topics listed by the National Climate Commission (National Climate Commission, 2016). The focus on this topic was demonstrated by the frequent occurrence of related keywords, such as maize (18 occurrences), wheat (16 occurrences), and rice (14 occurrences). These latter keywords were connected to evapotranspiration (57 occurrences, including evaporation), erosion (42 occurrences), runoff (19 occurrences), and soil moisture (17 occurrences). Especially noteworthy is that authors of Belgian water research have frequently combined soil/water erosion, land-use, and Belgium in their chosen keywords, suggesting their high concern on this topic in this research line. Besides, Ethiopia (56 occurrences) also appeared in this cluster, demonstrating a strong collaboration between Belgian and Ethiopian water researchers.

Water quality monitoring and pollution. Water experts have worked to support the EU water framework directive (WFD) (79 occurrences). This directive aims to "improve water quality of rivers, lakes, transitional waters, groundwater and coastal waters in the EU" (Council of the European Communities (CEC), 2000). The implementation of the WFD has called for intensive monitoring and assessment of the ecological and chemical status of the different water bodies in Belgium (Jager et al., 2016). Keywords analysis suggested that rivers (42 occurrences) and coastal waters (15 occurrences) have been the water bodies that deserved the most attention (Forio and Goethals, 2020; Kristensen and Bøgestrand, 1996; PMO Belgium, 2017). For example, the Scheldt estuary and the North Sea (24 and 12 occurrences, respectively) have played essential roles in Belgian economic and social development, but have been heavily affected by vessel transportation, sediment dredging and removal, agricultural run-off, and discharges from industrial cooling water and urban sewage systems (Meire et al., 2005). The anthropogenic activities were indicated in several keywords, i.e. eutrophication (34 occurrences) with excessive amount of nitrate (27 occurrences), nitrogen (22 occurrences), phosphorus (18 occurrences) and heavy metal contamination (23 occurrences). These topics were also focal points in the cluster of water pollution. Besides, the impacts of water pollution on biodiversity (32 occurrences) and coral (26 occurrences, including cold-water corals) have been greatly addressed by Belgian water research.

Climate Change. Similarly, Belgian studies have also intensively studied climate change impacts on temperature (43 occurrences), drought (73 occurrences including drought stress), agriculture (28 occurrences), water balance (36 occurrences), and biodiversity (32 occurrences). The increasing attention of climate change in Belgian water research was likely intertwined with the integration of this issues in the Belgian and global political agenda. In 2009, following the EU White Paper on Adaptation, the Belgian National Climate Commission adopted its first National Climate Plan (2009-2013) (National Climate Commission, 2010). This first plan was followed by more specific and consecutive plans (i.e. 2014-2017 and 2017-2020). All these plans recalled the impacts of increasing temperature on heatwave occurrence and drought causing increased mortality and adverse health impact (Sartor, 2004). Recently, Belgium faced meteorological droughts, such as the droughts in 2003, 2007, 2010, 2011, 2015, and 2018 (Gobin, 2018; Zamani et al., 2016). The Belgian scientific concerns in this issue were expressed by the increasing co-occurrences of drought and climate change as keywords in the publications.

Modeling as a key tool. Besides water technologies, Belgian water research often concerned modeling technology development and application (134 occurrences of model-related keywords), including integrated water resources modeling, inverse modeling, numerical modeling, optimization, model validation (16 occurrences), model simulation (18 occurrences) and sensitivity analysis (15 occurrences). These keywords appeared in almost all of the research lines, except for the water pollution cluster. Looking at the connection between these keywords and keywords from other research clusters, it appeared that model simulation and validation have been exploited to improve the efficiency of treatment plants in the first cluster, while inverse modeling (15 occurrences) has had a strong link with soil-water content (27 occurrences) and root water uptake (16 occurrences) in the water-stress cluster. Additionally, integrated modeling (18 occurrences) has been used in studies on water quality while experts in water management have often applied numerical modeling (15 occurrences) in their research.

3.2.2. Belgium - Global South water research

The main research hotspots conducted between Belgians and institutions from the Global South were relatively similar to the hotspots of overall Belgian water research, such as (waste/drinking) water treatment, water quality, climate change, and water stress (Figure 4). In particular, great attention has been paid on the topic of **water scarcity**, indicated by three clusters: water stress, water use efficiency and soil and water conservation. A high proportion of Belgium-Global South water research has been targeting the roles of water in agricultural production, i.e. agriculture (30 occurrences), irrigation (25 occurrences), and crop (60 occurrences). This reflected the important role of agriculture in the economic and social development in the Global South, and the strong link between water and food security (FAO, 2019). For example, rainfed agriculture has been producing most food for rural communities in developing countries, i.e. 95% of the farmed land in sub-Saharan Africa, almost 90 % in Latin America, and around 60 % in South and East Asia (Rockstrom et al., 2010; Wani et al., 2009).

Hence, research on water availability appeared as an important research hotspot. This research topic occupied two clusters with top author keywords drought (51 occurrences, including water stress and drought stress), water use efficiency (26 occurrences), and rain (32 occurrences, including precipitation). In this topic, researchers have targeted major crops such as rice (10 occurrences), maize (8 occurrences), wheat (5 occurrences), in Tunisia (6 occurrences), South Africa (5 occurrences), Niger (5 occurrences), and Mali (4 occurrences).

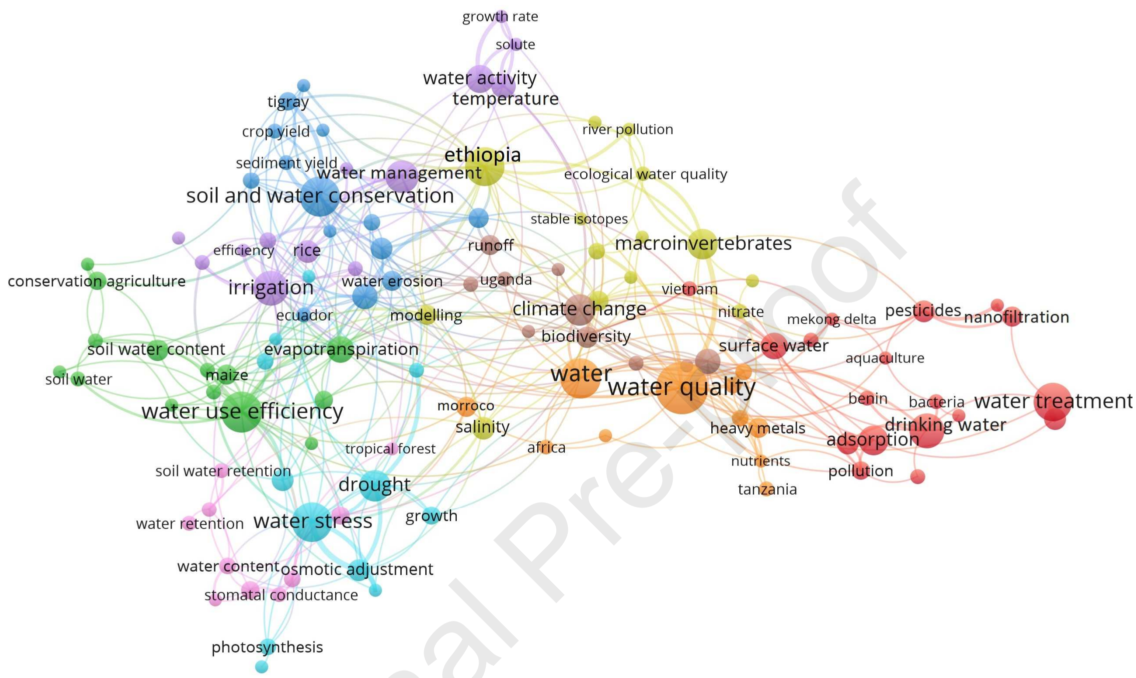

Figure 4. Most concerned keywords on Belgian water research for development cooperation from 1986 to 2019. The size of the text and circle are proportional to the number of publications. The keywords with the same color belong to one cluster representing their co-occurrence in publications. Some circles do not have text for clarity.

Water treatment were other important focuses of Belgium-Global South water research. This topic is the largest research cluster with 18 popular author keywords (154 occurrences). Limited access to proper sanitation and clean water has been a major problem in the Global South (World Water Assessment Programme UNESCO, 2012). Moreover, rapid population growth and urbanization have intensified the problems of water pollution in these countries. Particularly, heavy metal contamination, eutrophication, pesticides, water-borne diseases were the most dedicated topics that have been addressed by both Belgian and Global-South researchers. While researchers have targeted the problems of pesticides and water-borne diseases in ground and surface water in case studies in Vietnam and Benin, heavy metal contamination and eutrophication have been more interested in case studies in Morocco and Tanzania. Scientific collaboration with Ethiopia dealt with water pollution in rivers and groundwater. Noteworthy is that Mekong delta (5 occurrences) also appeared on the list, suggesting a scientific focus on the study of environmental impacts from intensive agriculture and aquaculture on this river.

Climate change also appeared as an important topic in the Belgium-Global South water research (17 occurrences). This can be a result of the early acknowledgment of climate change in the development agenda, recognizing that developing countries will be those which are affected the most to climate change and have the least means to adapt to it (van Ypersele, 2008). Many recommendations were proposed to increase development aid in capacities to challenge climate change in Belgian partner countries (van Ypersele, 2008). Moreover, climate change impacts need to be assessed on multidisciplinary sectors including water resources to create different short- and mid-term strategies for climate change adaptation. Hence, climate change shared strong links with its impacts on temperature (11 occurrences), salinity (10 occurrences), biodiversity (9 occurrences), water quality and resources (68 occurrences).

3.3. Belgian water research in support of the SDG 6

3.3.1. Quantitative contribution

Figure 5 shows the contribution of Belgian water research in topics related to SDG 6 over three periods, 1990-1999, 2000-2009, and 2010-2019. We disregarded the publications of Belgian water research published before 1990 due to their limited records on Scopus (less than 40 publications per year). It appears that the number of publications has increased unevenly among the SDG 6 targets. Since the last decade of the 21st century, there has been a substantial acceleration in the number of publications and citations underpinning targets 6.3, 6.4, 6.5, and 6.6, while less scientific attention has been paid for the other targets. Note that since a publication could be considered supportive for multiple targets, the number of publications or citations underpinning SDG 6 was not equal to the sum of the publications or citations for each of the eight targets. Regarding scientific impact, Belgian water research on SDG 6 related topics had an average of 25.6 citations per publication in which publications underpinning target 6.6 had the highest scientific impact with around 28.2 citations per publication on average. This was in contrast to publications supporting target 6.2 that had the lowest scientific impact with 22.3 citations per publication. Also noteworthy is that higher citations were in the publications published during 2000-2009 compared to the most recent publications during the last decade. This result can be attributed to the fact that citations need time to accumulate; hence research evaluation on the basis of bibliometrics can be limited (Bornmann and Leydesdorff, 2014).

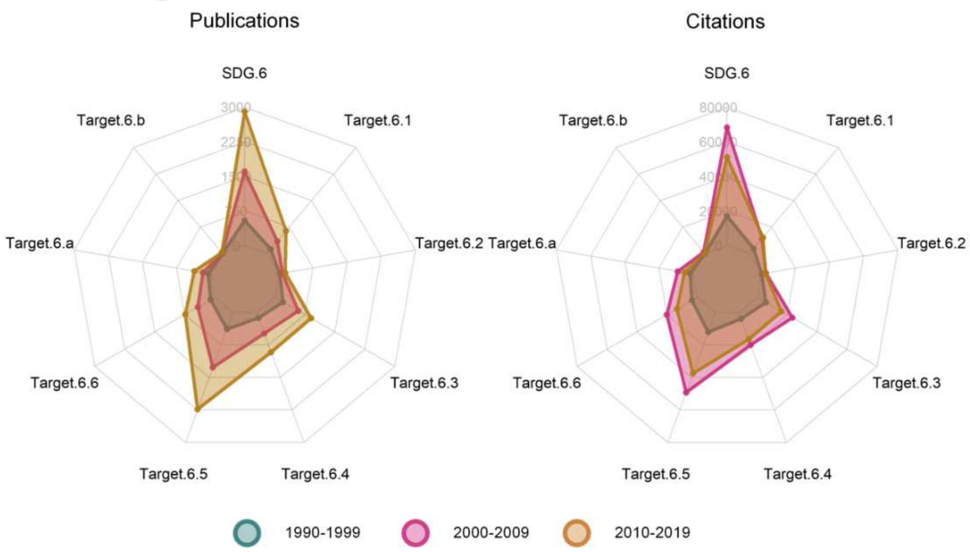

Figure 5. Belgian water research in support of the SDG 6 and each of its targets from 1990 to 2019. The scale of the radar charts show the number of publications and citations, respectively. Target 6.1: Provision of drinking water; Target 6.2:

Sanitation and hygiene services; Target 6.3: Treatment and reuse of wastewater and ambient water quality; Target 6.4: Water-use efficiency and scarcity; Target 6.5: Integrated water resources management including through transboundary cooperation; Target 6.6: Protecting and restoring water-related ecosystems; Target 6.a: International cooperation and capacity-building; Target 6.b: Participation in water and sanitation management.

The largest amount of scientific attention has been paid for target 6.5 (water management), which can be explained by the fact that integrated water management covers a very broad area of activities, such as planning, developing, distributing and managing, applied to different water resources, namely surface water, groundwater, and saline water. In contrast, fewer publications were dedicated to targets 6.2 and 6.b, which can be associated with their addressed issues that are more specific to developing countries, therefore, not central to Belgian research. Conversely, Belgian water research has paid high attention to wastewater quality and water scarcity (targets 6.3 and 6.4, respectively). The two research lines reflected the two most concerned issues related to water in Belgium. Belgium has been criticized by the European Commission in 2000 for their severe lack of wastewater treatment utilities (The European Commission DG XI, 2000). Meanwhile, tremendous efforts have been paid to improve this situation. From 2000 to 2009, the Walloon Region spent around 2.5 billion euros for the remediation of urban wastewater (Aquafin NV, 2006). Similarly, over the last 25 years, Aquafin has implemented nearly 3,000 projects for a total contract value of 3.7 billion euros to develop, optimize, and manage supra-municipal water treatment infrastructure in Flanders (Vlaamse Milieumaatschappij, 2018). The number of scientific publications on water treatment has also accelerated from around 20 publications during the 90s to around 120 publications over the last three years. This coincided with the increase of the wastewater purification capacity from only 26% in 1991 to 83% in 2016. In contrast to this common concern and interest from both policy agenda and academic world in Belgium, water scarcity and drought have been intensively studied in Belgian water research but received limited recognition from the authorities. River basin management plans in all regions, i.e. Flanders, Brussels, and Wallonia, only mentioned briefly drought as a non-significant pressure (European Commission, 2015). This inattention was contradicting to historical consideration to securing water quality and quantity, and mitigating the risk of flooding (Akter et al., 2018).

3.3.2. Qualitative contribution

Figure 6 illustrates the top 20 most common author keywords in publications in support of the achievement of SDG 6 and its targets. Overall, while water and water quality were the two most common authors keywords that can be used in multidisciplinary water research, the top author keywords of each target were relatively distinctive and reflected the overarching aim of their target. Particularly, Belgian water research supporting target 6.1 appeared to focus on advanced drinking water treatment and supply technologies. Also, the top author keywords in target 6.1 showed that the most concerned issues in Belgian drinking water research have been pesticides, water-borne diseases, and arsenic. These topics also emerged as specific topics regarding drinking water in a recent report on the quality of drinking water (Vlaamse Milieumaatschappij, 2019). As mentioned above, less scientific attention has been paid to target 6.2, which was indicated by the fact that its publications have the second least number of author keywords among all targets. Since Belgian water research showed very few interests in open-defecation topics, research on sanitation and hygiene in target 6.2 has been oriented towards drinking water topics. In addition, environmental quality standards under the EU

Water Framework Directive have also been targeted in the publications supporting target 6.2. The EU Water Framework Directive is one of the most important pieces of European environmental legislation. The EU-WFD quality standards are threshold levels of pollutants that are used to protect both the environment and human health (Crane and Babut, 2007).

Concerning target 6.3, water quality and treatment were the most popular author keywords. Especially noteworthy was the high rank of water treatment modeling in the authors' keyword list. Modeling-related author keywords, such as integrated modeling, mathematical modeling, ecological modeling, and dynamic modeling, occur 305 times, which was double the number of occurrence of the second most popular author keyword (water quality with 150 occurrences). The total number of modeling applications in all targets were not completely reflected in Figure 6 because of a large variety of modeling techniques. Other modeling-related terms have been placed in lists of author keywords such as calibration, uncertainty analysis, and sensitivity/identifiability analysis. More details of the total number of occurrences of modeling-related author keywords can be found in Figure D26 in Supplementary Material D. In fact, water digitalization and artificial intelligence, together with bio- and nanotechnologies, are cross-cutting technologies that have been applied by Belgian wastewater specialists to optimize and improve WWTPs (Verstraete and Vlaeminck, 2011). As a result, Belgium has already fulfilled target 6.3 on wastewater treatment with 95.7% of the proportion of safely treated domestic wastewater flow (United Nations, 2019).

Furthermore, climate change, drought, irrigation, and agriculture have been of great interest in Belgian water research in support of target 6.4. Almost all of the top popular author keywords in support of target 6.4 considered water scarcity and its impact on agriculture and irrigation. This highlighted the high concerns of Belgium on future water availability, especially under the context of climate change. Despite having a good score for treated wastewater and water use efficiency, Belgium is struggling to achieve the second indicator of target 6.4 on water stress. Belgium is among the 32 countries experiencing water stress between 25 and 70 percent (FAO and UN-Water, 2018). According to the report of OECD (2007), the intensity of freshwater abstraction in Belgium was at about 45% of total renewable resources, the highest among OECD countries. Although this number dropped by 18% between 1995 and 2002, the freshwater withdrawal per capita remained above the average value of OECD Europe. Since the global renewable freshwater resources per capita have been declining by more than 54% over the last 50 years (Rayne and Forest, 2013), the water stress in Belgium is more likely to be worse. It was concluded that due to the declining trend of global freshwater availability, countries facing water stress like Belgium will have to deal with a serious constraint on socioeconomic development and environmental protection (Chellaney, 2015). From that perspective, currently limited awareness of water-stress issues from crucial actors, such as intermediaries and multipliers, needs to be improved to integrate the drought risk assessment in their actions (Tröltzsch et al., 2016). Moreover, strategies for reduction of water footprint in Belgium has also been recommended to reduce freshwater pressure. The annual water footprint per person in Belgium (2.700 m^3/capita/year) is double the global average and exceeds the footprint of its neighboring countries such as the Netherlands (2.300 m^3/capita/year) and the United Kingdom (1.700 m^3/capita/year) (Hoekstra et al., 2017; Vincent et al., 2011). To save domestic water resources but ensure national product supply, Belgium has externalized significant portion of their water footprints as part of its international trade by importing water-intensive products and exporting commodities that are less water intensive (Chapagain et al., 2006). Chellaney (2015) reported that Belgium is among the highest virtual-water import dependencies with 80% of its water footprint that has been externalized via international trade.

Water quality monitoring and modeling became one of the focal points in Belgian water research contributing to target 6.5-water management. The combination of monitoring and modeling as a supporting tool of water management was reflected in the most popular author keywords in target 6.5 with 105 occurrences of monitoring and 110 occurrences of modeling (excluding redundant terms of different modeling techniques). The implementation of the EU WFD has been pivotal to consolidate, develop and optimize monitoring and modeling programs to support systematic, integrative, and multidisciplinary assessments of water at several scales (EU Water Framework Directive, 2003; Hojberg et al., 2007 ; Vanrolleghem, 2010). Monitoring and modeling allow decision makers to understand and measure the impact of alternative water management strategies. Belgium possesses a very intensive network of monitoring stations for both surface water and groundwater, composed of 1,614 monitoring sites in total (European Commission, 2015). Given few natural lakes in Belgium, rivers are the main focus of surface water monitoring programs by government institutions in Flanders, Wallonia, and Brussels-capital regions, occupying 870 stations (Kristensen and Bøgestrand, 1996; PMO Belgium, 2017). Details of monitored parameters and their frequency are transparent and available in river basin management plan (RBMP) (Flemish Environment Agency, 2009).

Belgium situates within four river basin areas, of which the Meuse and the Scheldt river basin area cover around 44% and 33% of the Belgian territory, respectively, while the Rhine and Seine cover only small areas (European Commission, 2015). Except for the Seine, the three other transboundary rivers have their RBMP within international/intra-Belgian agreements and coordination (European Commission, 2015). As such, Belgium has fulfilled the second indicator of target 6.5 on transboundary water cooperation (United Nations, 2019). On the other hand, since Belgium has funded less than 75% of the expected contributions and by regulation for transboundary cooperation (PMO Belgium, 2017), it has not yet met the requirement of the first indicator of target 6.5 on integrated water management. Belgian water research has further a focus on ecosystems and biodiversity, which is reflected in the top keywords in support of target 6.6. Rivers appeared as top author keyword in the analysis. Overall, river-related terms, such as rivers, river basins, river water quality, river modeling, and others appeared in total 224 times in the list of author keywords. This was almost four times higher than the number of occurrences of water quality (61 occurrences) which was the second most popular author keyword in support of this target. Belgium has been struggling to restore the water quality of its surface water bodies as only 38% of natural surface water bodies achieve a good or better ecological status (PMO Belgium, 2017). Particularly, eutrophication and pesticide contamination remained a critical issue of river water quality. This has been a result of substantial pressure from agriculture leading to diffuse pollution, hydrological regulation and river morphological modifications (PMO Belgium, 2017).

The means-of-implementation (MOI) targets of all Goals emphasize a strong commitment of the 2030 Agenda for sustainable development. They aim to revitalize and enhance global engagement and also bring together different types of actors in society (UN General Assembly, 2015). There are two MOI in SDG 6 (targets 6.a and 6.b). In support of these targets, Belgium water research focused on three main topics, i.e. water management, climate change, and water framework directive. These topics are transboundary water issues that require actions at both local and global scales and will be discussed in the next session.

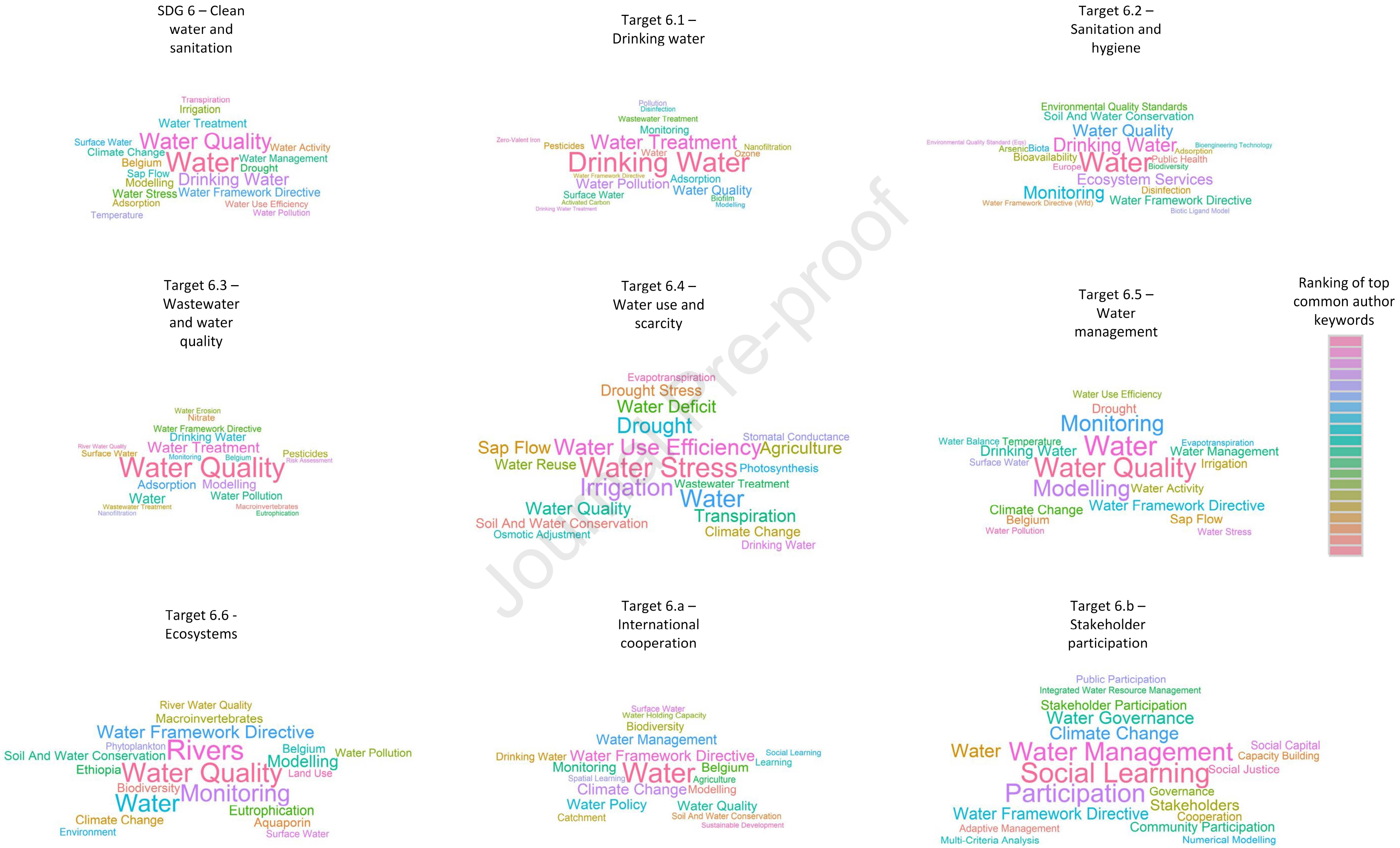

Figure 6. Word clouds of the top 20 most common author keywords in Belgian water research in support of the achievement of SDG 6 and each of its targets. The size and the color of the texts reflect their popularity within a target but not among the targets.

3.4. Belgium-Global South water research in support of the SDG 6

3.4.1. Quantitative contribution

Figure 7 depicts the historical contribution of Belgium-Global South water research in the achievement of SDG 6 over three periods, 1990-1999, 2000-2009, and 2010-2019. The distribution among targets regarding the number of publications and citations in Belgium-Global South water research remains similar to those in Belgian water research. This similarity can be explained by the international mobility of researchers towards Belgium. Seventy percent of researchers mobility towards Belgium originates from low- and middle-income countries, who often have to pursue further education and employment in high-income countries (Pillai et al., 2018). Researcher mobility resulted in numerous scientists having affiliations from their country of birth working in research institutions of their destination country (Mills et al., 2011). Consequently, their publications in Belgium-Global South water research often included both affiliations from Belgium and their country of birth in the Global South. Many researchers, who have affiliations from China, Brazil, and India, have been participating in Belgian water research, yet these countries did not appear in the list of the most popular author keywords.

Scientific capacity and access to information were unevenly distributed on a global scale. Sixty percent of total scientific output was carried out by researchers from high-income countries (Independent Group of Scientists appointed by the Secretary-General, 2019; Pillai et al., 2018). Researchers mobility can facilitate multidirectional transfers of STI between the Global North and the Global South. This can alleviate the uneven global distribution of scientific capacity and knowledge access. As such, Global Partnerships are key issues in the 2030 Agenda. Scientific cooperation and research capacity-building can help to facilitate the development and dissemination of relevant technologies of reaching the SDGs (Kloke-Lesch, 2015).

Overall, Belgium-Global South water research accounted for only 17.8% of the total publications of Belgian water research. This proportion increased considerably for the last two decades. This proportion was only 3.5% before 2000, it boosted to 14.3% within the first decade of the 21st century and 25.2% over the last decade. Note that high percentage of publications as a result of Belgium-Global South collaborations could be found in targets 6.2 and 6.6, i.e. 34.1% and 32.3%, respectively, over the last decade. The Global South has been struggling to achieve the former target. Despite an increase from 76% to 91% of human population having access to clean drinking water, over 1.8 billion people still had to use fecally contaminated water as a result of poor sanitation and hygiene (United Nations, 2016). A share of great concerns about the well-being of water-related ecosystems between Belgian researchers and their counterparts in Global South can be explained by the rapid loss of wetlands, deforestation and rising pollution in the Global South. This has been catalyzed by an increased rate of urbanization, industrialization, and population growth in the Global South. Water-related ecosystems, such as lakes, rivers, and vegetated wetlands, have been among the world's most biologically diverse environments that sustain the global hydrological cycle, provide natural freshwater, and purify water (UN Environment, 2018). However, it was reported that at least 33% of wetlands have vanished since 2009 worldwide (Gardner and Finlayson, 2018) while 90% of untreated sewage in developing countries is directly discharged into water bodies (Connor, 2015). As a result of severe degradation of freshwater ecosystems, a loss of about one-third of the global biodiversity was recorded (UN Water, 2015).

Regarding the scientific impact, a publication of Belgium-Global South water research had on average 20.6 citations, which was on average five citations lower than that of Belgian specific water research. However, this difference has been recently reduced, from seven citations during the last decade of the 21st century to only one citation over the last decade. This marked the increase in research capacity of scientists from the Global South and scientific interests to their works, leading to their higher scientific impact. Among all targets, higher scientific impact was also recorded in publications supporting target 6.6 with 22.9 citations per publication while publications aiming target 6.b had the least citations (on average 10.1 citations per publication).

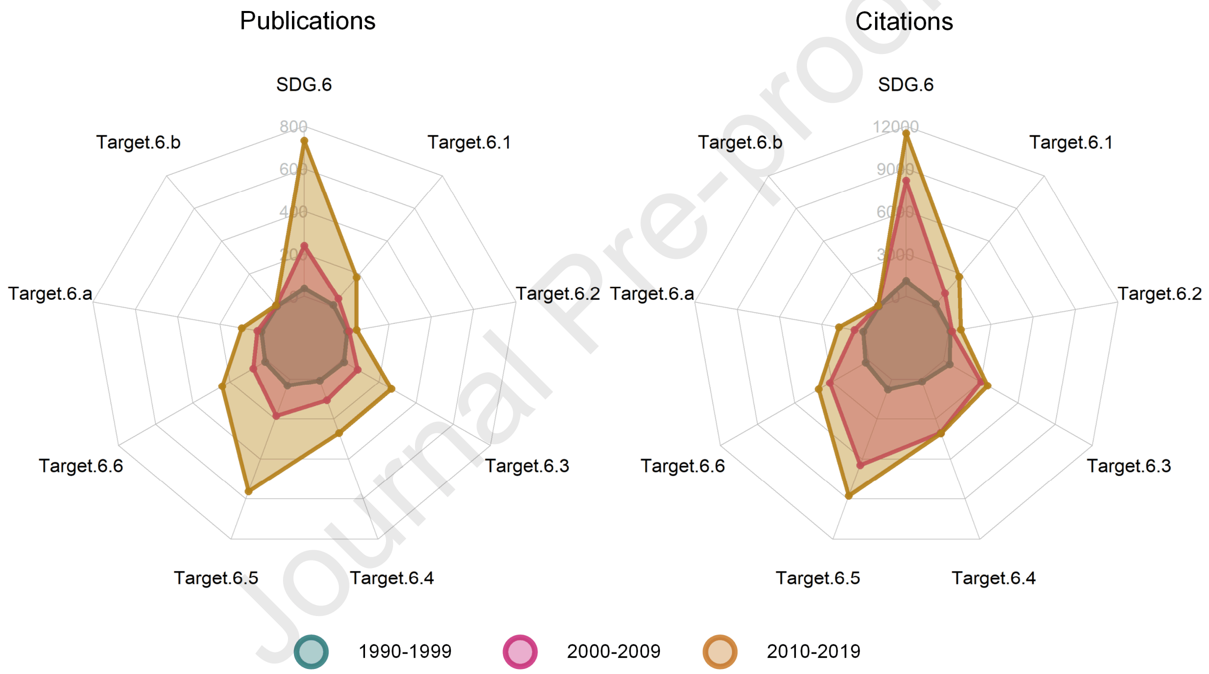

Figure 7. Belgium-Global South water research in support of the achievement of SDG 6 and each of its targets from 1990 to 2019. The scale of the radar charts show the number of publications and citations, respectively. Target 6.1: Provision of drinking water; Target 6.2: Sanitation and hygiene services; Target 6.3: Treatment and reuse of wastewater and ambient water quality; Target 6.4: Water-use efficiency and scarcity; Target 6.5: Integrated water resources management including through transboundary cooperation; Target 6.6: Protecting and restoring water-related ecosystems; Target 6.a: International cooperation and capacity-building; Target 6.b: Participation in water and sanitation management.

3.4.2. Qualitative contribution

Figure 8 illustrates the top 20 most common author keywords in publications of Belgium-Global South water research in support of the achievement of SDG 6 and its targets. Similar to their counterpart of Belgian water research, the top author keywords of each target were relatively distinctive and reflected the main objective of the target. More importantly, substantial similarities could be found between the top 20 most common author keywords of Belgium-Global South water research and those of Belgian water research. Fifteen out of the top 20 most common author keywords in publications in support of the achievement of SDG 6 were the same between two groups. This resemblance could also be observed in publications contributing to targets 6.5, 6.1, 6.3, and 6.4. Comparing this resemblance over the three periods, we observed an increase in the number of common author keywords over time. More details of this resemblance can be found in Figure D27 in Supplementary Material D. This increasing similarity between research lines of the two groups implied the growing mutual scientific interests between Belgian researchers and Global South researchers in water research, demonstrating the effective knowledge transfers between Belgium and its research partners. This result also suggested that Global South countries have shared similar water issues with their counterparts in the North as a result of either their economic and social development or the global scale of these issues. Hence, these researchers have urged to solve same water problems with their partners in the Global North.

Still, several differences in research interests in target 6.2, target 6.6, and two MOI targets could be found when comparing both groups. Regarding target 6.2, relatively high scientific attention has been paid to sanitation problems in agriculture and irrigation. Untreated wastewater has frequently been reused for irrigation in developing countries, posing high health risks to farmers and consumers (Drechsel and Keraita, 2019; Ho, Long and Goethals, Peter 2020; Ho et al., 2019). Further, in support of target 6.6, specific scientific focus went to issues related to the impacts of water quality and availability on agriculture. Logically, agriculture has played an important role in the economic and social development of developing countries (Cervantes-Godoy and Dewbre, 2010; Diao et al., 2010). Ensuring the quality and quantity of water supply for agricultural development is therefore essential. Regarding two MOI targets, several top keywords refer to countries and regions where case studies have been conducted, such as Ethiopia, Ecuador, Andres, and developing countries. The strong collaboration between Belgian and Ethiopian water researchers could be seen by the frequent occurrence of Ethiopia or Tigray, the northernmost of the nine regions of Ethiopia, in the top popular author keywords.

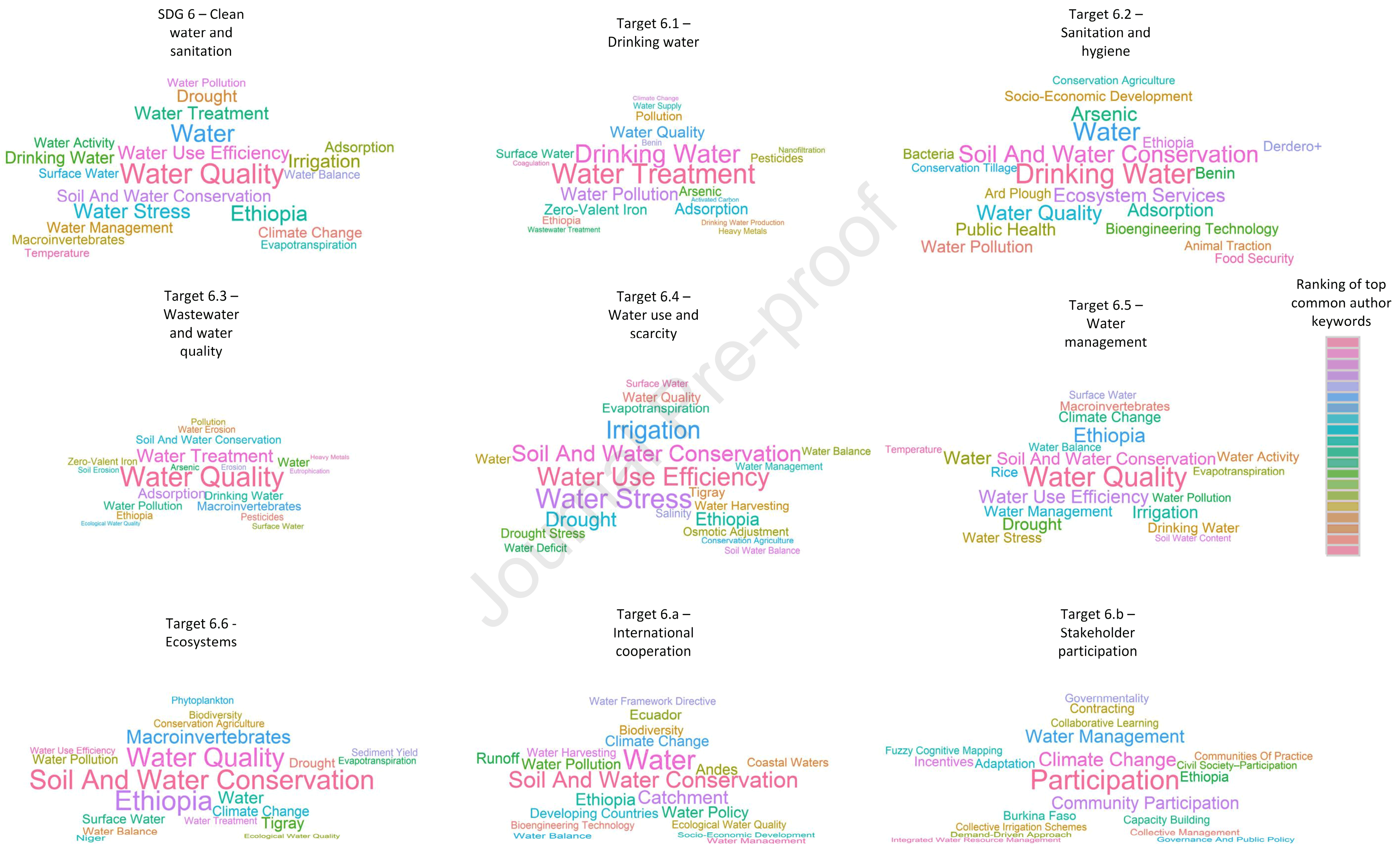

Figure 8. Word clouds of the top 20 most common author keywords of Belgium-Global South water research in support of the achievement of SDG 6 and each of its targets. The size and the color of the texts reflect their popularity within a target but not among the targets.

4. Conclusion

We proposed a method for integrating bibliometric analysis and text mining to extract and analyze the scientific knowledge base addressing issues underlying SDG 6 and its targets. The approach can be used for systematically exploring scientific literature and assessing the contribution of science and knowledge information systems in achieving sustainable development in different countries and regions. We dedicated a specific focus on Belgian research and the collaborations with countries globally and with the Global South in particular. The publication lists selected by our search queries have been integrated into an online, interactive and searchable dashboard to facilitate the identification of research and expert by practitioners and policy makers, and hence strengthen transfer and uptake of science in the real work context. The method is sufficiently generic and can easily be applied to analyze the scientific basis of other SDG implementation programs or for other countries.

The obtained records of water research showed increasing attention of science on the water sector. While EU countries have had the biggest share in water research publications over the last decade, a rapid increase in research outputs from Chinese institutions made China the most productive country in 2019. Despite accounting for less than one percent of the total global publications, Belgian water research had a relatively high publication rate of 2.9 publications per 100,000 inhabitants in 2019, which was higher than France (1.9), and Germany (2.1), but lower than the United Kingdom (3.1) and the Netherlands (4.8). These neighboring countries, together with the United States, have long been the largest partners in Belgian water research, although collaborations with China have surged over the last five years, positioning the country as a top-three partner for Belgium. A raising collaboration rate was also found between Belgium and the Global South countries, such as Ethiopia, South Africa, and Vietnam.

Research hotspots of Belgian water research were identified in descending order of their occurrences in the publications as follows: (1) (waste/drinking) water treatment; (2) water stress; (3) water management; (4) water quality monitoring; (5) climate change; and (6) water pollution. This orientation of Belgian water research has been supportive of the achievement of targets 6.3, 6.4, 6.5, and 6.6. Less scientific attention has been paid for the other targets. Results suggested that monitoring and modeling are essential tools for integrative and multidisciplinary assessments of water quality and systematic optimization of water treatment and supply systems. Eutrophication, pesticides, and heavy metal contamination have also received much attention, suggesting that they remain a critical issue for river water quality and drinking water. Water digitalization and artificial intelligence, together with bio- and nano-technologies, are cross-cutting technologies that have been applied by Belgian water specialists to improve the performance of (waste/drinking) water treatment utilities and hence reaching targets 6.1, 6.2, and 6.3. Besides, Belgian water research has been targeting issues related to water scarcity and its impacts on agriculture, reflecting its increased attention to drought and water shortage. The impacts of climate change on water availability and agriculture have drawn increasing attention in both Belgian scientific and political spheres.

The main research hotspots of Belgium-Global South water research were similar to those of overall Belgian water research. This similarity is attributed to three potential reasons: (1) the enhanced mobility of researchers from Global South countries towards Belgium; (2) the growing mutual scientific interests between Belgian researchers and Global South researchers in water research; and (3) the common local and global water issues. Still, some differences in research interests were found in Belgium-Global South water research. Particularly, a high proportion of water research under the context of this collaboration has been targeting the interaction between water and agriculture, i.e. the roles of water in agricultural production and the impact of agriculture on water quality. This attention reflected the important role of agriculture in the economic and social development in the Global South. High scientific focus in support of targets 6.2 and 6.6 have been paid related to sanitation problems in agriculture, such as heavy metal contamination, eutrophication, pesticides, and water-borne diseases.

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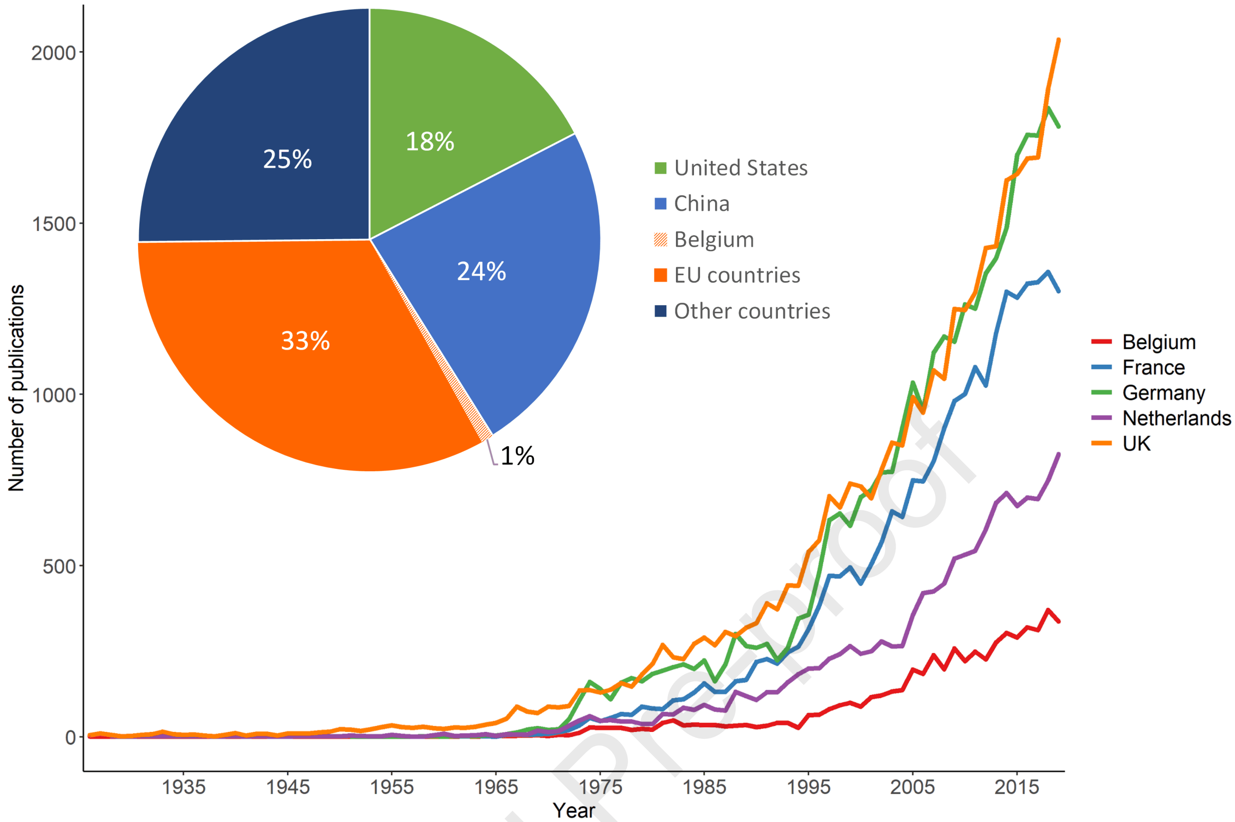

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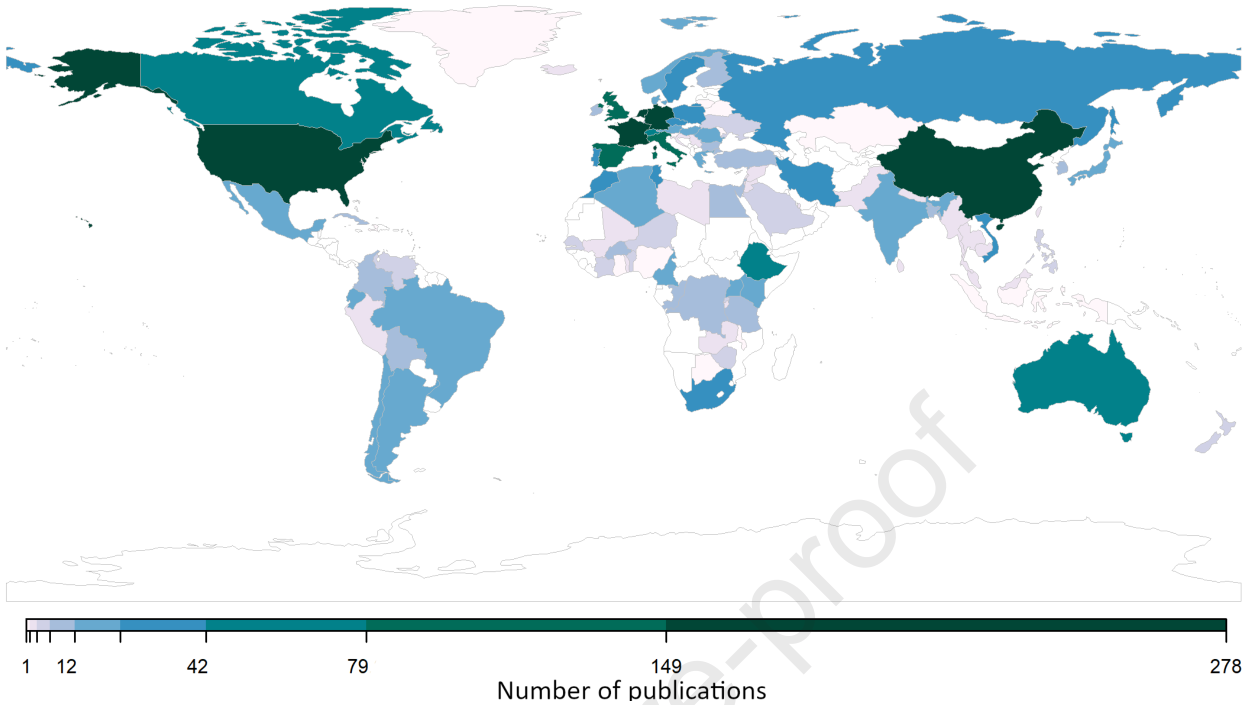
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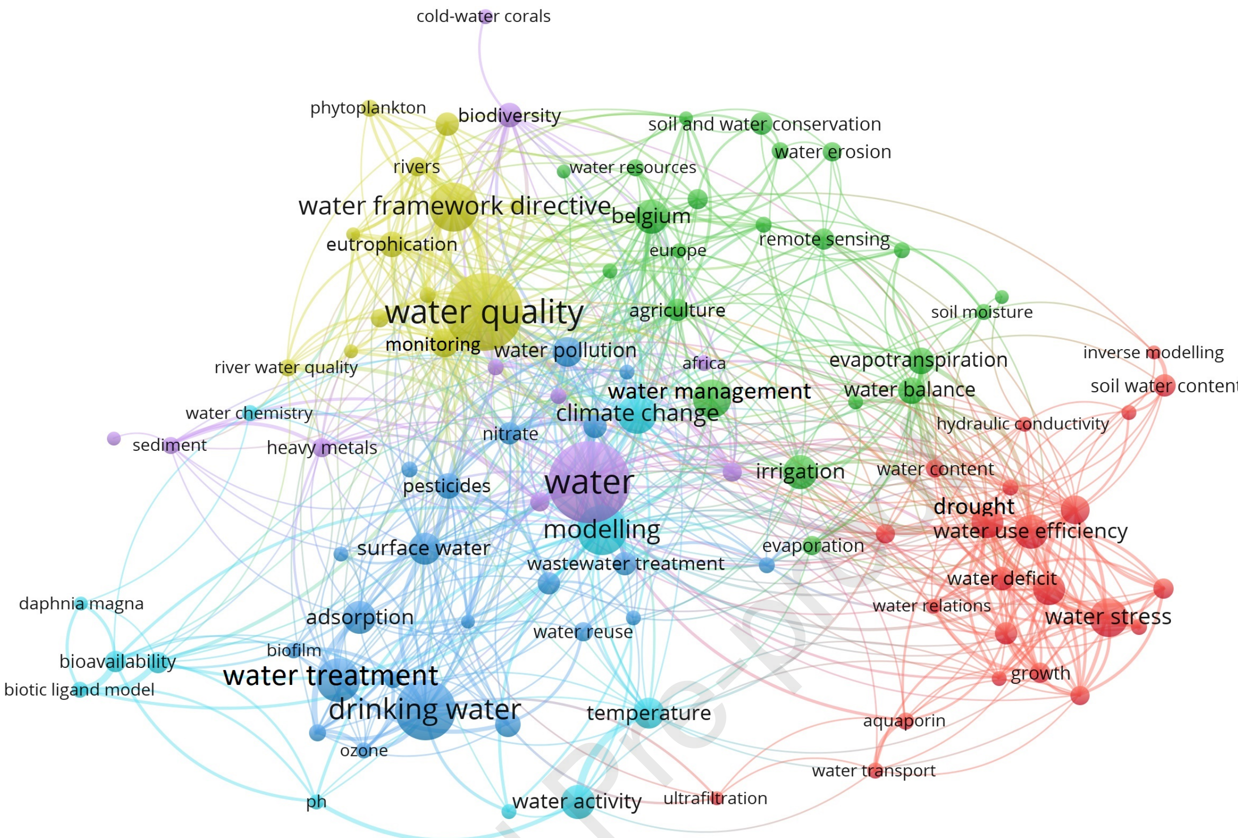
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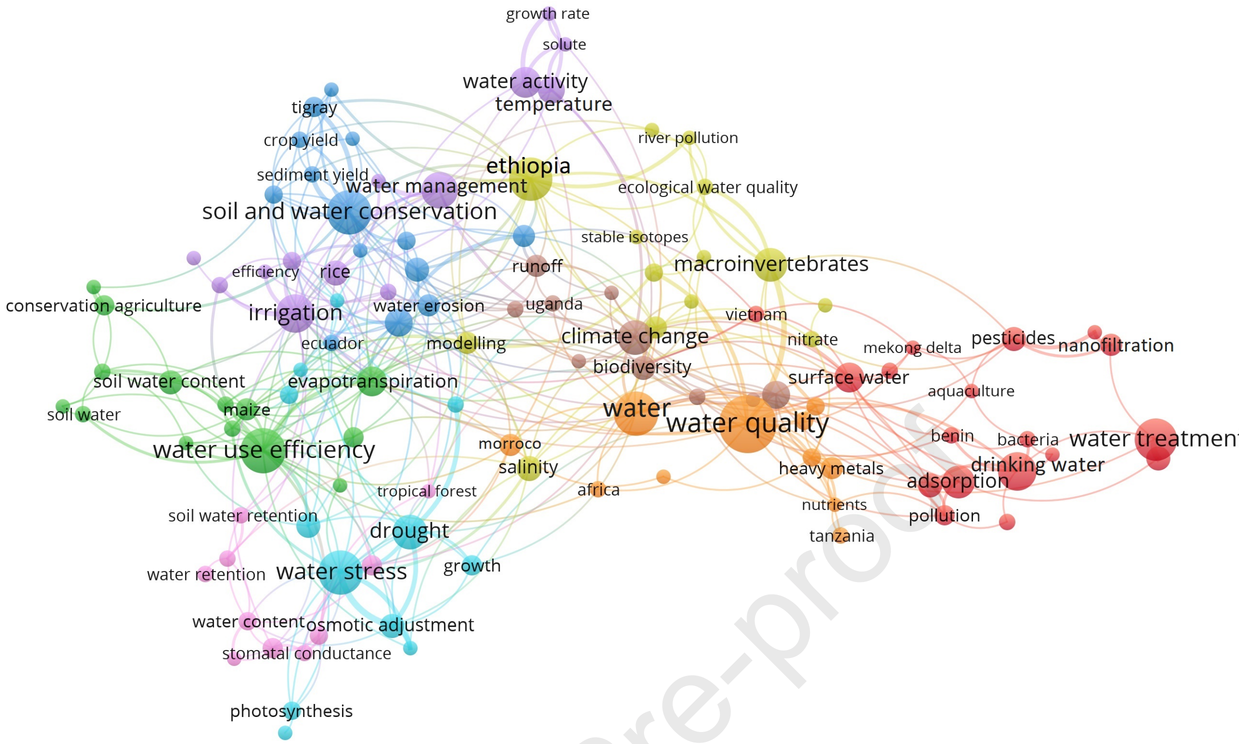
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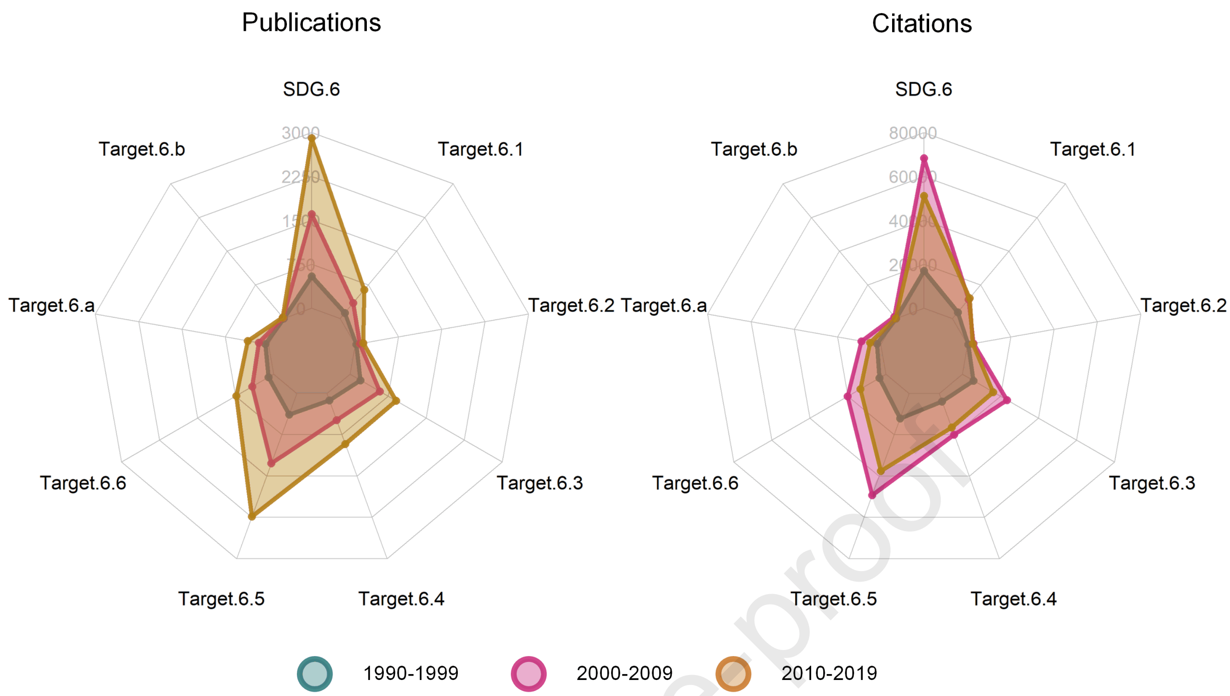
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Citations
SDG.6
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Target.6.3
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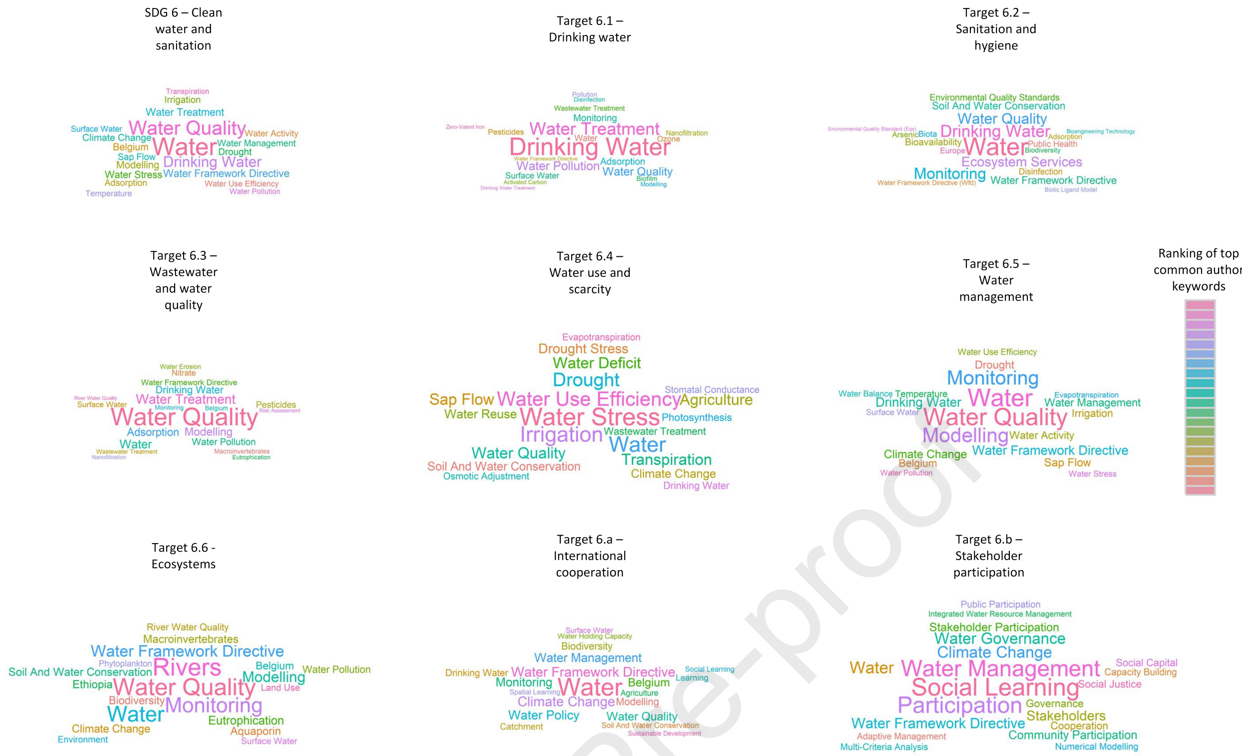
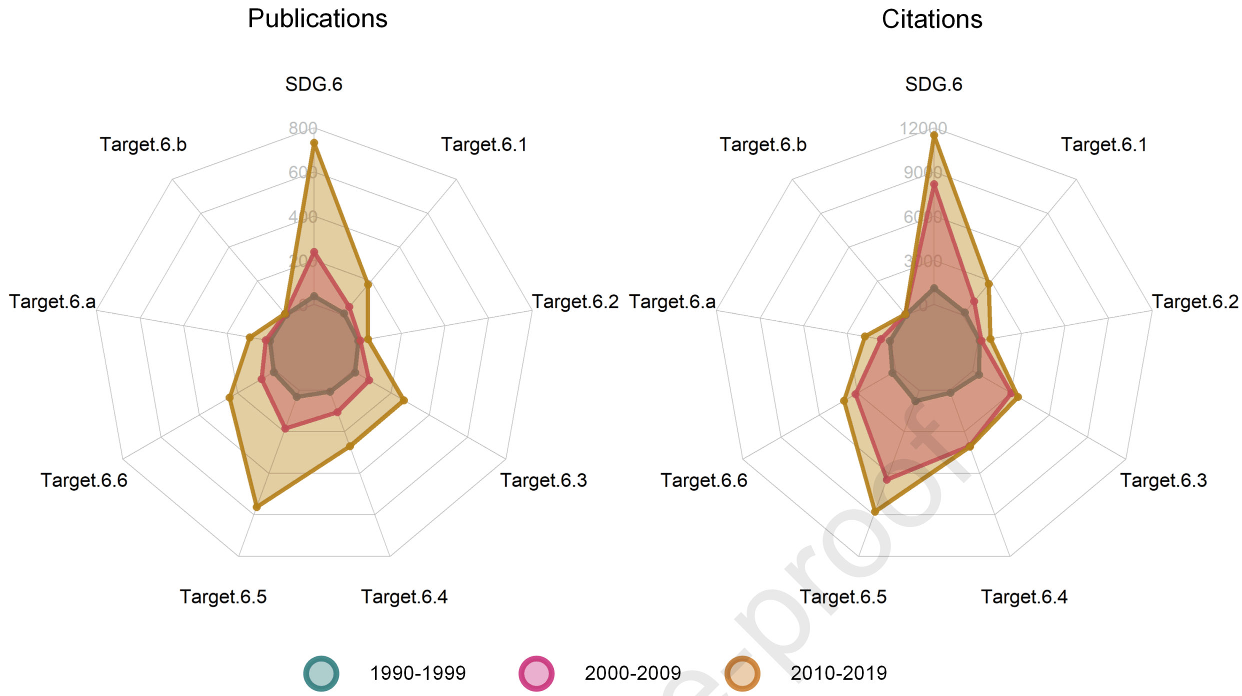

SDG 6 – Clean water and sanitation
Target 6.1 – Drinking water
Target 6.2 – Sanitation and hygiene
Target 6.3 – Wastewater and water quality
Target 6.4 – Water use and scarcity
Target 6.5 – Water management
Ranking of top common author keywords
Target 6.6 - Ecosystems
Target 6.a – International cooperation
Target 6.b – Stakeholder participation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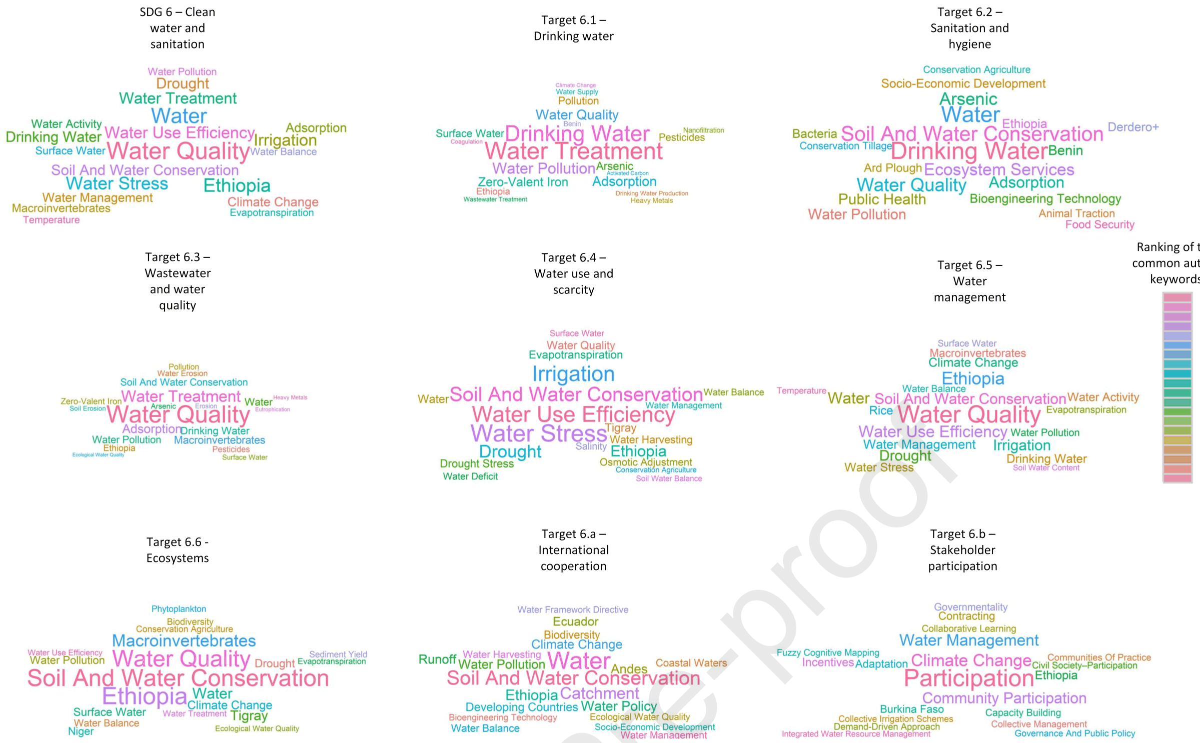
SDG 6 – Clean water and sanitation
Water Pollution
Drought
Water Treatment
Water
Water Activity
Drinking Water
Water Use Efficiency
Irrigation
Adsorption
Surface Water
Water Quality
Water Balance
Soil And Water Conservation
Water Stress
Ethiopia
Water Management
Macroinvertebrates
Climate Change
Evapotranspiration
Temperature
Target 6.1 – Drinking water
Pollution
Water Quality
Surface Water
Drinking Water
Pesticides
Water Treatment
Water Pollution
Arsenic
Zero-Valent Iron
Adsorption
Ethiopia
Target 6.2 – Sanitation and hygiene
Conservation Agriculture
Socio-Economic Development
Arsenic
Water
Ethiopia
Derdero+
Bacteria
Soil And Water Conservation
Conservation Tillage
Drinking Water
Benin
Ard Plough
Ecosystem Services
Water Quality
Adsorption
Public Health
Bioengineering Technology
Water Pollution
Animal Traction
Food Security
Target 6.3 – Wastewater and water quality
Pollution
Water Erosion
Soil And Water Conservation
Zero-Valent Iron
Water Treatment
Water
Water Quality
Adsorption
Drinking Water
Water Pollution
Macroinvertebrates
Ethiopia
Pesticides
Surface Water
Target 6.4 – Water use and scarcity
Surface Water
Water Quality
Evapotranspiration
Irrigation
Water
Soil And Water Conservation
Water Balance
Water Management
Water Use Efficiency
Water Stress
Tigray
Water Harvesting
Drought
Salinity
Ethiopia
Drought Stress
Osmotic Adjustment
Conservation Agriculture
Water Deficit
Soil Water Balance
Target 6.5 – Water management
Surface Water
Macroinvertebrates
Climate Change
Ethiopia
Water Balance
Temperature
Water
Soil And Water Conservation
Water Activity
Rice
Water Quality
Evapotranspiration
Water Use Efficiency
Water Pollution
Water Management
Irrigation
Drought
Drinking Water
Water Stress
Soil Water Content
Ranking of top common author keywords
Target 6.6 - Ecosystems
Phytoplankton
Biodiversity
Conservation Agriculture
Macroinvertebrates
Water Use Efficiency
Sediment Yield
Water Pollution
Water Quality
Drought
Evapotranspiration
Soil And Water Conservation
Ethiopia
Water
Climate Change
Surface Water
Water Treatment
Tigray
Water Balance
Niger
Ecological Water Quality
Target 6.a – International cooperation
Water Framework Directive
Ecuador
Biodiversity
Climate Change
Water Harvesting
Runoff
Water Pollution
Water
Andes
Coastal Waters
Soil And Water Conservation
Ethiopia
Catchment
Developing Countries
Water Policy
Bioengineering Technology
Ecological Water Quality
Water Balance
Socio-Economic Development
Water Management
Target 6.b – Stakeholder participation
Governmentality
Contracting
Collaborative Learning
Water Management
Fuzzy Cognitive Mapping
Communities Of Practice
Incentives
Adaptation
Climate Change
Civil Society–Participation
Participation
Ethiopia
Community Participation
Burkina Faso
Capacity Building
Collective Irrigation Schemes
Demand-Driven Approach
Collective Management
Integrated Water Resource Management
Governance And Public Policy

- New method to extract and analyze the publications supporting SDG 6 & its targets
- Belgian water research had a high publication rate compared to its neighbors
- A raising collaboration rate between Belgium and the Global South countries
- Biggest share of Belgian water research has focused on targets 6.3, 6.4, 6.5 & 6.6
- Findings and dashboard are important for optimizing the development of SDGs

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: